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EXECUTIVE SUMMARY

# SPECTRUM MANAGEMENT APPROACHES FOR E-BAND (70/80GHz) IN SELECTED MARKETS

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Celebrating 30 years as global specialist advisers on telecoms, media and technology (TMT)

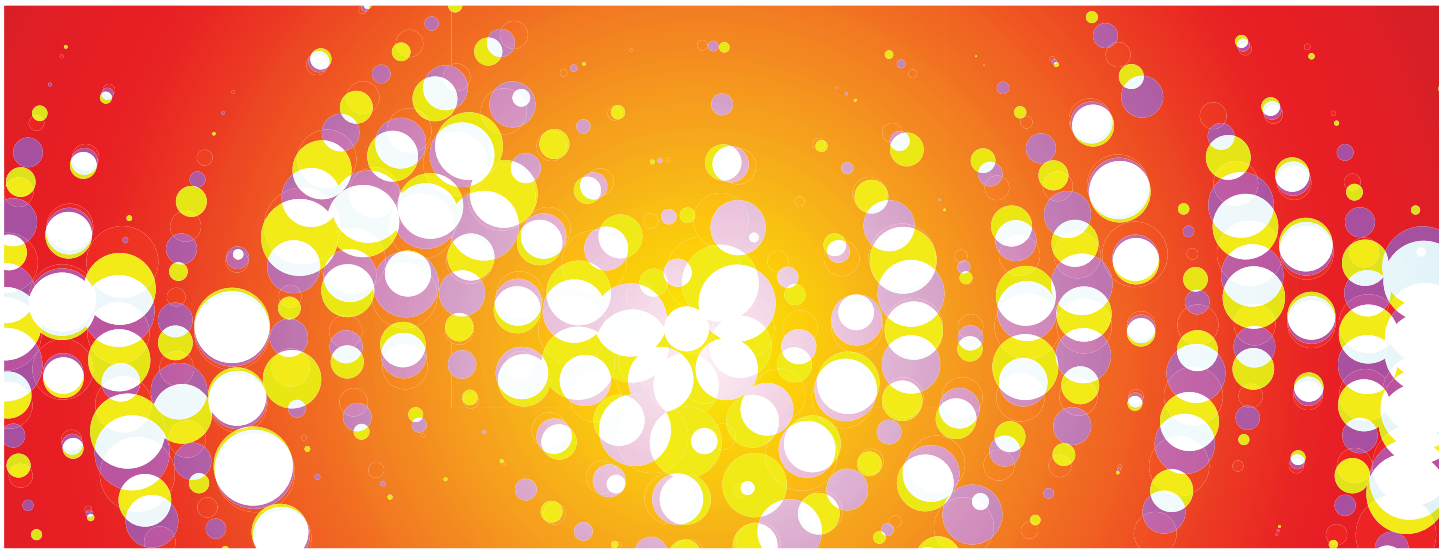
# Introduction

This is the executive summary of a report prepared by Analysys Mason, exploring how E-band frequencies have been licensed for use in selected markets around the world and identifying the regulatory regimes best suited to current and future uses of the band.

E-band is part of the Extremely High Frequency (EHF) portion of the radio spectrum (broadly 30GHz to 300GHz), corresponding to wavelengths between 1mm and 1cm, hence the term 'millimetre waves'). Internationally, E-band includes the frequencies from 71–76GHz and from 81–86GHz.

The report has been prepared in the context of growing demand for high-capacity point-to-point and point-to-multipoint wireless links, both within telecoms networks (e.g. for backhaul) and to provide high-capacity wireless connectivity to businesses and consumers, and in the context of new and innovative uses beyond conventional fixed point-to-point links. The properties of E-band frequencies, particularly the available bandwidth and the channel sizes (which, being in multiples of 250MHz, offer scope for considerably higher capacity to be delivered per link than is possible in other frequency bands allocated for fixed services use), make this band ideally suited to meeting these demands. In addition, the short wavelength of frequencies in the millimetre portion of the radio spectrum, where E-band sits, means that the potential for interference between neighbouring links is reduced, compared to the lower-frequency bands. This implies that regulators have much more scope to implement simplified coordination mechanisms for the licensing of links in E-band, compared to other frequency bands used for point-to-point services.

The overall objective of the report is to highlight the benefits of adopting flexible, lightly licensed approaches when allocating these frequencies, exploiting the properties of this band to avoid the need for fully coordinated, interference-managed approaches to assignment.





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# 1.1 The E-band presents attractive physical properties in terms of bandwidth and spectrum management

### Properties of millimetre-wave bands

In general, millimetre-wave bands above 60GHz have favourable properties for providing high-capacity wireless links, due to the large amounts of spectrum available in these bands (making wide channel widths a possibility, to achieve very-high-capacity links). This is one of the key drivers for use of millimetre-wave bands, compared to lower-frequency bands (which enable links to operate over larger distances, but with less capacity available). For example, a research report published by the UK regulator, Ofcom, illustrates the increase in capacity typically available in millimetre-wave bands, relative to link distance.[1]

Frequencies in E-band (typically 71–76GHz and 81–86GHz) are particularly useful providing high-capacity wireless links for two reasons: the existing international allocation of this frequency band for fixed service use (which has the benefit that radio equipment has been developed for this band), and the availability of harmonised bandwidth (up to 2×5GHz, in multiples of 250MHz), which provides a large amount of potential capacity.

An interesting feature of E-band is that, although located high in the millimetre-wave region of the radio spectrum, where signal absorption levels are high, E-band is located above the oxygen absorption peak occurring at around 60GHz and hence the usefulness of the band (in terms of the operating ranges that are possible) can be more similar to fixed services bands around 30–40GHz[2]. The physical properties of E-band spectrum also result in reduced potential for interference between systems (compared to lower-frequency bands), ensuring that multiple users can access the spectrum without constraint on the capacity or quality of links.

Technological development to facilitate the use of millimetre-wave bands has resulted in availability of highly directional antennas for use in E-band. These 'pencil beam' antennas not only make it possible to simplify coordination between links (due to reduced risk of interference) but they also potentially improve the performance of links in terms of their directionality and range.

### Regulatory approaches to E-band spectrum

A further factor which should favour wider take-up is the flexibility in use of this band that a number of regulators have offered by opening it for use on a self-coordinated (also referred to as 'lightly licensed') basis. The self-coordinated management approach to E-band was originally introduced in the USA and a number of other markets have subsequently adopted similar approaches. A small number of regulators (two, based on our survey of selected countries around the world) have removed the need for frequency coordination for E-band altogether, and provide access to E-band on a licence-exempt (unlicensed) basis. In practice, however, the characteristics of at least one of these licence-exempt approaches (in the Czech Republic) are somewhat similar to the self-coordinated approaches in the other countries we have profiled in this report, in that E-band users are required to register details of deployed links in an online database, facilitating exchange of information and interference resolution between different users of the band, without requiring regulatory intervention.

The use of these self-coordinated management approaches has the benefit of facilitating a quicker turnaround on licence applications (useful, since one of the main benefits of fixed radio links is that they can be deployed more rapidly than wired connections). Self-coordinated licensing also has the potential to reduce access costs for using the spectrum (i.e. spectrum fees), if regulators do not need to recover the cost of administering detailed frequency assignment and interference assessment within the fee for the links. The fact that regulators around the world are increasingly adopting self-coordinated management approaches in E band is also a factor that can support the emergence of innovative applications in such bands – as evidenced in the USA, where experimental licences filed for E-band demonstrate possible new uses that may emerge in future.

A growing number of countries are opening up E-band for point-to-point use based on our research. For example, Nigeria made 70/80GHz spectrum available on a self-coordinated, light licensed basis in 2015, and countries such as Indonesia and Tanzania plan to put licensing processes in place in the near future.

Overall, this makes E-band frequencies an excellent choice for deployment of point-to-point and other fixed wireless links, which can be implemented rapidly and cheaply, as well as being scalable for high-capacity provision.

| Frequency range | Achievable distance for point-to-point links | Achievable link bandwidth for point-to-point links |
|---|---|---|
| Below 3GHz | Large e.g. tens of km | Small: typically below 10Mbit/s |
| 3–10GHz | Large e.g. tens of km | Medium: up to 100s of Mbit/s per link |
| 10–20GHz | Medium e.g. 10–20km | Medium: up to 100s of Mbit/s per link |
| 20–50GHz | Small e.g. less than 10km | Large: 500Mbit/s and above |
| 50GHz and above | Very small e.g. a few km | Very large: 1Gbit/s or more |

**FIGURE 1.1:** PROPERTIES OF SPECTRUM USED FOR POINT-TO-POINT LINKS
[SOURCE: OFCOM, ANALYSYS MASON, 2015]

[1] http: stakeholders.ofcom.org.uk/binaries/consultations/spectrum-review

[2] For example, see http://stakeholders.ofcom.org.uk/consultations/70-80ghz-review/statement/

# 1.2 An increasing number of countries are adopting flexible licensing and management approaches to E-band

### Countries surveyed

As part of this study we have surveyed the approach taken by regulators to making E-band spectrum available in 18 different markets.

The range of licensing approaches that we identified from our survey is summarised in Figure 1.2 below. It is notable that the majority of the countries surveyed have adopted either self-provided or licence-exempt approaches when opening up E-band for commercial use.

One of the countries surveyed – the UK – has implemented a self-coordinated approach to part of E-band, and a coordinated, interference-managed approach to the other part. The original approach to E-band in the UK was to make the full band available on a self-coordinated basis. However, the conditions were changed following a public consultation by the UK regulator, Ofcom, in 2013, which revealed that some E-band users (mainly mobile operators, using the spectrum for mobile network backhaul) favoured that part of the band which was being more actively managed by Ofcom, in order to obtain a greater level of interference certainty which is desirable for public networks with high availability objectives. The UK's approach is profiled in the main part of this report, along with case studies on seven other countries, all of which use self-managed, light licensed and licence-exempt approaches: the USA, Mexico, Brazil, the UK, the Czech Republic, Nigeria, Qatar and Australia.

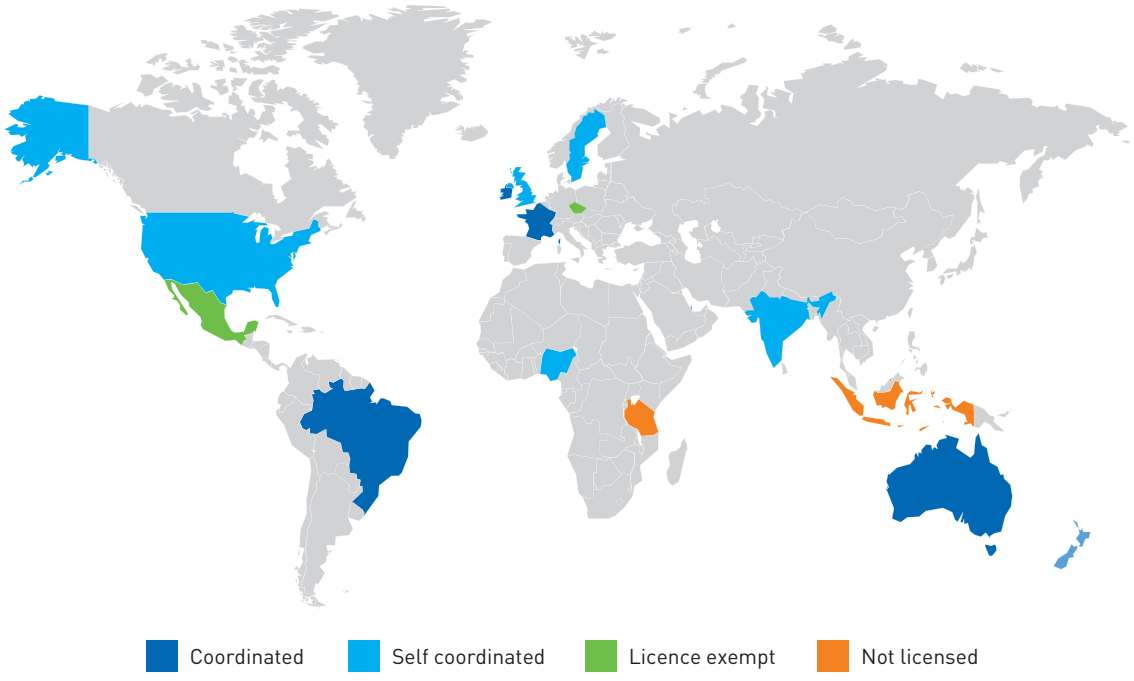



**FIGURE 1.2:** ILLUSTRATION OF E-BAND MANAGEMENT APPROACHES ADOPTED IN SURVEYED COUNTRIES
[SOURCE: ANALYSYS MASON, 2015]

## Main uses of E-band

We have found that countries which have opened E-band for licensing have largely done so to facilitate fixed point-to-point use. According to the international table of frequency allocations, a number of other co-primary allocations exist in E-band, in addition to fixed point-to-point services. Some of these allocations are not currently used (e.g. we are not aware of any mobile systems operating in E-band). In a number of countries, point-to-point links share E-band capacity with other uses (predominantly government use and radio astronomy) and a number of regulators have implemented specific coordination procedures to ensure that licensed links do not interfere with these other uses.

A summary of the allocated uses of E-band frequencies is shown in Figure 1.3 below.

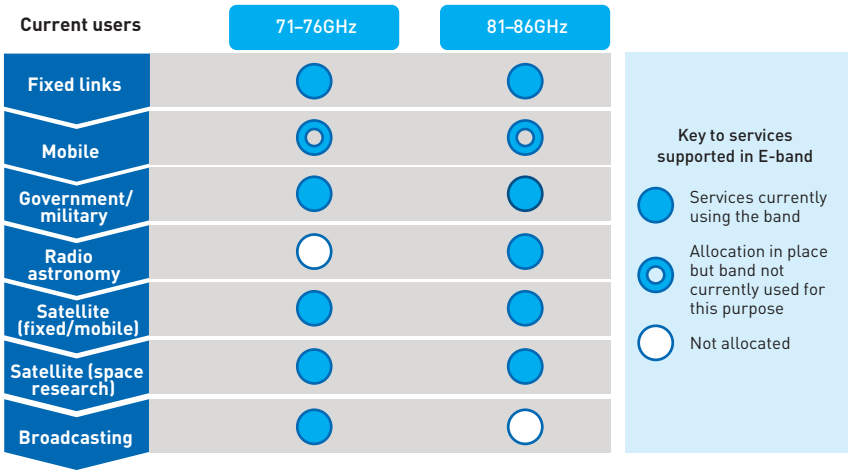



**FIGURE 1.3:** SUMMARY OF INTERNATIONAL ALLOCATIONS IN E-BAND
[SOURCE: ANALYSYS MASON, 2015]

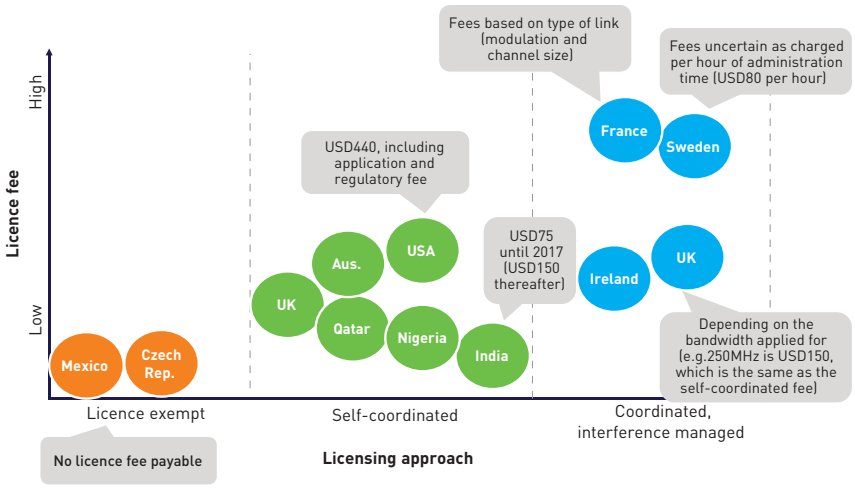



**FIGURE 1.4:** RANGE OF SPECTRUM FEES FOR E-BAND [SOURCE: ANALYSYS MASON, 2015]

## E-band spectrum fees

We have found that spectrum fees for E-band range from zero (i.e. no cost, in countries that have opted to make E-band available on a licence-exempt basis, such as the Czech Republic) to around USD150–450 for a typical self-coordinated link. In countries where E-band is licensed using a coordinated, interference-managed approach, it is not possible to determine the exact fee in all cases – in France, for example, the fee is based on the type of link (e.g. USD619 for a 250MHz bandwidth, 16QAM link) whereas in Sweden the fee is calculated based on the time to administer the licence (USD80 per hour).

An interesting finding from our research is that in a number of countries where a coordinated, interference-managed approach is used for E-band, the spectrum fee is comparable with those for the self-coordinated approaches. In Ireland and the UK for example, the fee for a coordinated E-band link can be as low as USD150, depending on the bandwidth applied for).

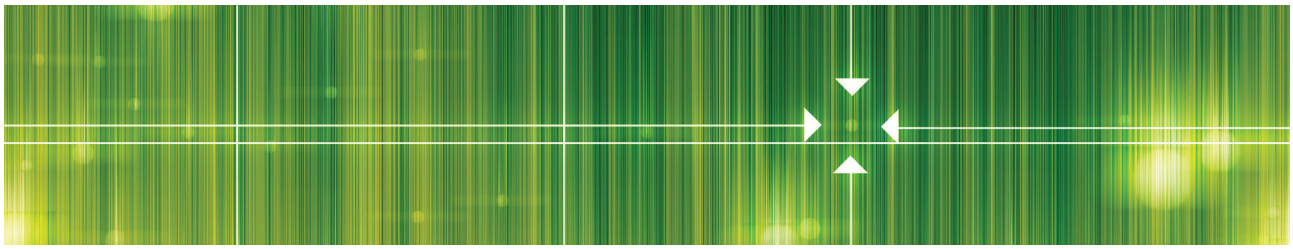
A summary of the range of fees that applies in the case study countries is provided below. A comparison of the fee levels broken down by component fees

[3] https://apps.fcc.gov/els/GetAtt html?id=163551&x=.

[4] We also surveyed the status of the E-band in the Philippines, Peru and the DRC, but were unable to find complete information to develop case studies.

[5] That is, as contained in the Radio Regulations of the International Telecommunication Union.

# 1.3 Self-coordinated management and light-licensing approaches appears conducive to unlocking the benefits of the E-band for upcoming needs



Based on our review of the management approaches to E-band implemented by the countries profiled in this report we have identified the key benefits of self-coordinated access to E-band, as summarised in Figure 1.5 below.

Many of the self-coordinated management approaches being applied to E-band licensing are supported by online databases that licensees use to upload licence applications and to obtain information on available link locations, as well as details of existing use that must be protected from interference.[6] In some cases database provision has been outsourced to commercial third parties. For example, three companies currently provide this service in the USA; a licensee can choose to register with any one of these, and systems are updated such that each database contains the full set of licensing information.

In many markets, although spectrum is earmarked for point-to-point use, there is the potential for other innovative wireless uses to make use of the same spectrum provided these can be shown to be compatible with existing point-to-point use (i.e. the self-coordinated approach to licensing typically works on a first-come, first-served basis, with incoming licensees having to ensure that their systems do not interfere with existing ones. Hence there is the possibility of innovative uses being facilitated, providing these do not interfere with the existing use as established by the online databases).

Use of E-band frequencies is still emerging in some markets (and the band is yet to be opened for use in some markets, despite an allocation for link use applying internationally). Hence although we have found limited evidence that outcomes in terms of use of the band are strongly influenced by the licensing approach, it is to be expected that the self-coordinated, light licensing approaches being implemented in a growing number of markets should reduce the cost and administrative barriers for new users to deploy systems in E-band, encouraging uptake. Furthermore, increasing update in use of E-band incentivised by light licensing should not compromise the integrity or usability of the band, thanks to its physical properties. Overall, the attractive properties of this frequency band – including the simplified licensing approaches being used – are likely to spur further innovative technology development for future use of this band.

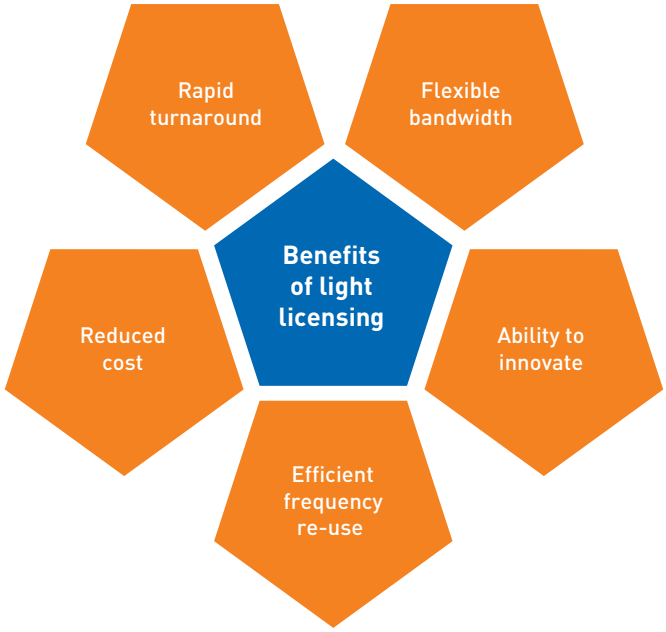



**FIGURE 1.5:** BENEFITS OF SELF-COORDINATED, LIGHT LICENSING IN E-BAND [SOURCE: ANALYSYS MASON, 2015]

[6] A number of countries which are implementing self-coordinated licensing have indicated that they intend to migrate to online databases but are currently using manual approaches until the online tools have been developed; these include the UK, Nigeria and Qatar.

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